CHAPTER 3

INLETS AND BOX DRAINS

3-1. General.

a. Inlet structures to collect storm runoff at airfields and heliports may be built of any suitable construction material. The structures must ensure efficient drainage of design-storm runoff in order to avoid interruption of operations during or following storms and to prevent temporary or permanent damage to pavement subgrades. Most frequently, reinforced concrete is the material used although brick, concrete block, precast concrete, or rubble masonry have also been used. The material, including the slotted drain corrugated metal pipe to handle surface flow if employed, should be strong enough to withstand the loads to which it will be subjected.

b. Field inlets are usually those located away from paved areas. Box drains, normally more costly than field inlets, are usually located within paved areas to remove surface drainage.

c. Local practices and requirements governing field inlets greatly influence design and construction details. Experience has indicated that the features described in paragraph 3-2 should be considered by the designer.

3-2. Inlets versus catch basins.

Catch basins are required to prevent solids and debris from entering the drainage system; however, their proper maintenance is difficult. Unless the sediment basin is frequently cleaned, there is no need for catch basins. Since catch basins are not necessary when storm drainage lines are laid on self-cleaning grades, proper selection of storm drain gradients greatly reduce the need for catch basins. Whenever practical ordinary inlets should be used instead of catch basins.

3-3. Design features.

a. Structures built in connection with airport drainage are similar to those used in conventional construction. Although standard type structures are usually adequate, occasionally special structures will be needed.

b. Grating elevations for field inlets must be carefully coordinated with the base or airport grading plan. Each inlet must be located at an elevation which will ensure interception of surface runoff. Increased overland velocities immediately adjacent to field inlet openings may result in erosion unless protective measures are taken. A solid sod annular ring varying from 3 to 10 feet around the inlet reduces erosion if suitable turf is established and maintained on the adjacent drainage area. Prior to the establishment of turf on the adjacent area, silt may deposit in a paved apron around the perimeter or deposit in the sod ring thereby diverting flow from the inlet. In lieu of a sod ring, a paved apron around the perimeter of a grated inlet may be beneficial in preventing erosion and differential settlement of the inlet and the adjacent area as well as facilitating mowing operations.

c. Drainage structures located in the usable areas on airports should be designed so that the grating does not extend above the ground level. The tops of such structures should be 0.2 of a foot below the ground line (finished grade) to allow for possible settlement around the structure, to permit unobstructed use of the area by equipment, and to facilitate collection of surface runoff.

d. A grating in a ponded area operates as a weir under low head situations. At higher heads, however, the grating acts as an orifice. Model tests of a grating shown in the typical plan of a double inlet grating (fig 3-1) indicate that vortex action influences the discharge characteristics when the head exceeds 0.4 foot. Hydraulically acceptable grates will result if the design criteria in the above figure are applied. For the entire area, the system of grates and their individual capacity will depend on the quantity of runoff to be handled and the allowable head at the grates. Head limitations should not exceed 0.5 foot.

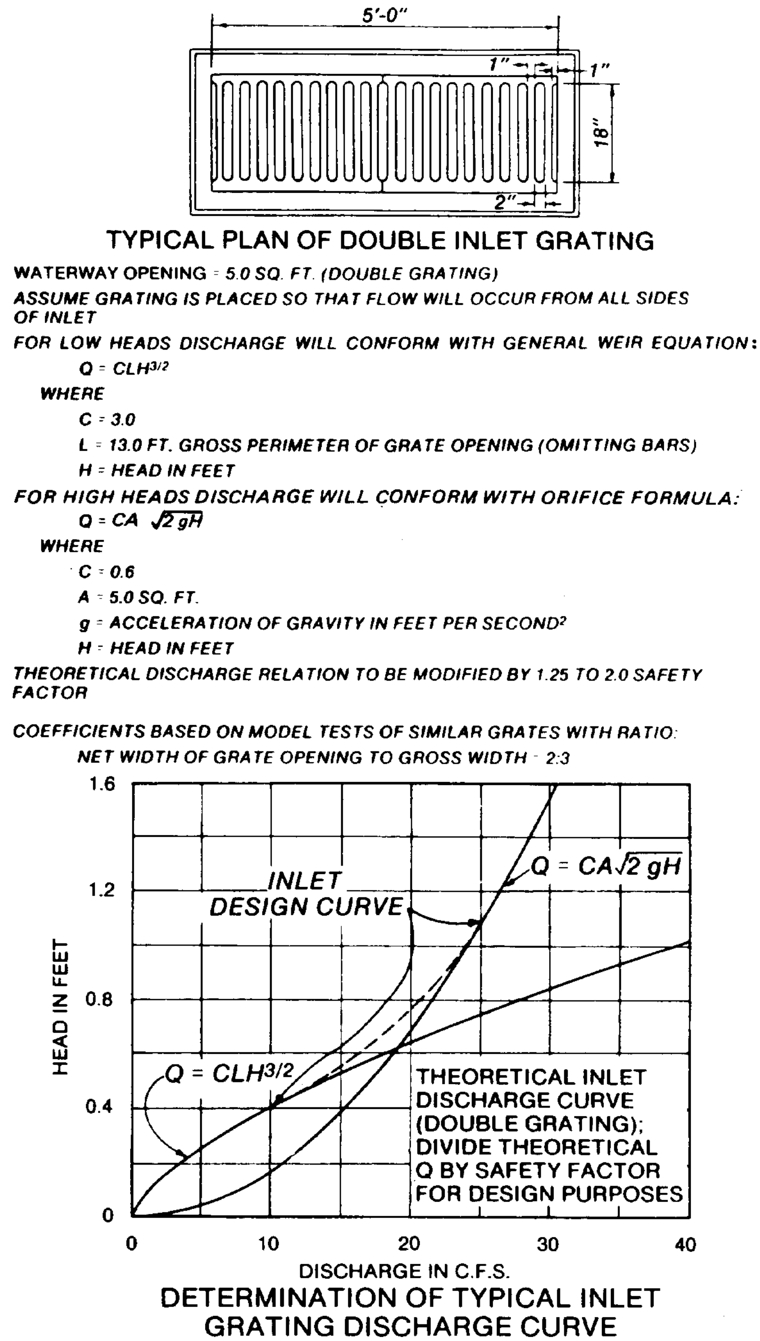

Figure 3-1. Determination of typical inlet grating discharge curve.

e. A grating in a sloping gutter will intercept all water approaching the gross width of grate opening if the length of grate is greater than the upper trajectory of inflow. Grating bars will be placed parallel to the direction of gutter flow, and spacers between bars will be avoided or located below the surface of the grate. Eighteen inches is the minimum length of opening necessary for grates with a ratio of net to gross width of opening of 2:3. To prevent possible clogging by debris, the safety factors mentioned below will be applied.

f. Discharge characteristics of gratings are primarily dependent on design and the local rainfall characteristics. A safety factor of 1.5 to 2.0 will be used to compensate for collection of debris on the field gratings in turfed areas. In extensively paved areas a safety factor of 1.25 may be used in design.

g. Grates may be made of cast iron, steel, or ductile iron. Reinforced concrete grates, with circular openings, may be designed for box drains. Inlet grating and frame must be designed to withstand aircraft wheel loads of the largest aircraft using or expected to use the facility. As design loads vary, the grates should be carefully checked for load-carrying capacities. Selection of grates and frames will depend upon capacity, strength, anchoring, or the requirement for single or multiple grates. Suggested design of typical metal grates and inlets is shown in figures 3-2 and 3-3.

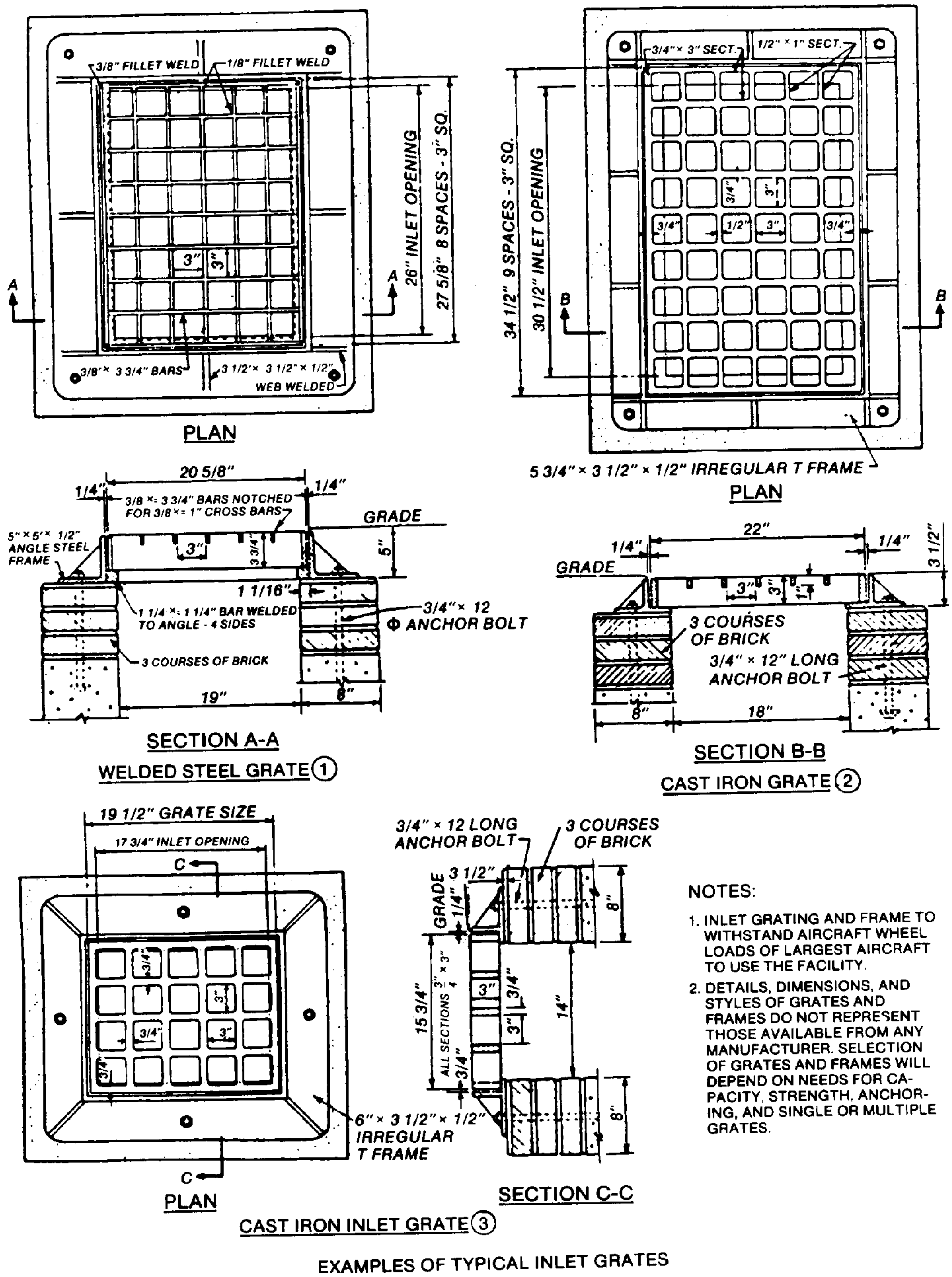

Figure 3-2. Examples of typical inlet grates.

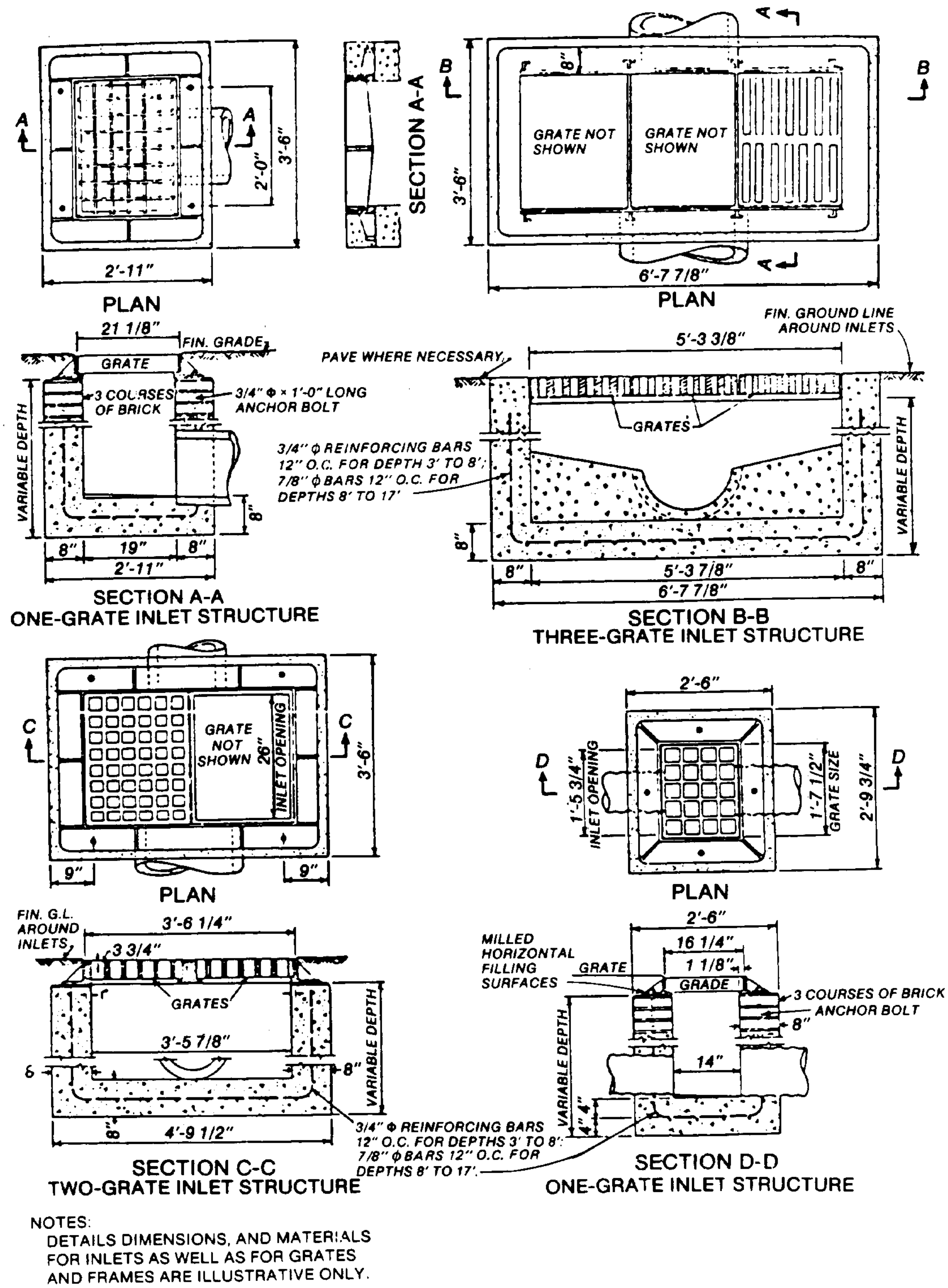

Figure 3-3. Examples of inlet design.

h. Commercially manufactured grates and frames for airport loadings have been designed specifically for airport loadings from 50 to 250 pounds per square inch. Hold-down devices have also been designed and are manufactured to prevent grate displacement by aircraft traffic. If manufactured grates are used, the vendor must certify the design load capacity.

i. The size and spacing of bars of grated inlets are influenced by the traffic and safety requirements of the local area. Nevertheless, in the interest of hydraulic capacity and maintenance requirements, it is desirable that the openings be made as large as traffic and safety requirements will permit.

j. For rigid concrete pavements, grates may be protected by expansion joints around the inlet frames. Construction joints, which match or are equal to the normal spacing of joints, may be required around the drainage structure. The slab around the drainage structure should include steel reinforcements to control cracking outwardly from each corner of the inlet.

3-4. Box drains.

a. Where box drains are used within paved areas to remove surface drainage, no special inlet structures are required and a continuous-type grating, generally covering the entire drain, is used to permit entrance of water directly into the drain. Box drains are generally more costly than conventional inlets. Accordingly, their use will be restricted to unusual drainage and grade situations where flow over pavement surface must be intercepted such as near hangar doors. The design and construction details of the box drain will depend on local conditions in accordance with hydraulic and structural requirements. However, certain general details to be followed are illustrated by the typical section through a box drain in a paved area shown in figure 3-4. The walls of the box drain will extend to the surface of the pavement. The pavement will have a free thickened edge at the drain. An approved expansion-joint filler covering the entire surface of the thickened edge of the pavement will be installed at all joints between the pavement and box drain. A ¾-inch-thick filler is usually sufficient, but thicker fillers may be required. Grating for box drains can be built of steel, cast iron, or reinforced concrete with adequate strength to withstand anticipated loadings. Where two or more box drains are adjacent, they will be interconnected to provide equalization of flow and optimum hydraulic capacity.

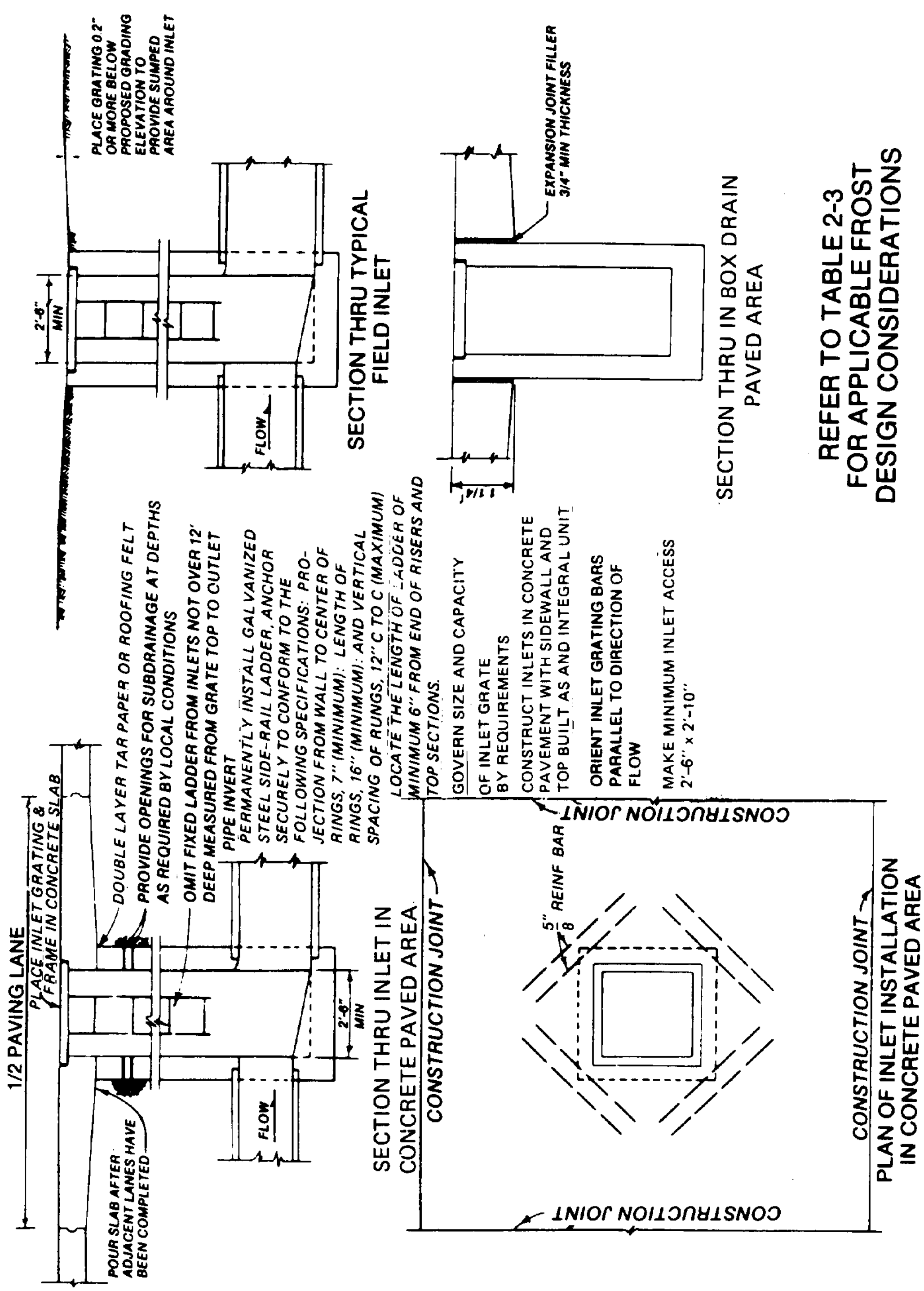

Figure 3-4. Typical inlet and box drain designs for airfield and heliport storm drainage systems.

b. A number of box drains similar to those shown in figure 3-4 have failed structurally at several installations, Causes of failure are the inability of the drain walls to resist the movement of the abutting pavement under seasonal expansion and contraction, the general tendency of the slope pavement to make an expansion movement toward the drain wall while the thickened edge is restrained from moving away from the drain, and the infiltration of detritus into joints. Figure 3-5 indicates a successful box drain in use at Langley Air Force Base. The design provides for the top of the box drain wall to terminate at the bottom of the abutting pavement. A typical drain cover is a

10-inch-thick reinforced concrete slab with inserted lightweight circular pipes used for the grating openings. While only 4-inch-diameter holes have been indicated in the figure, additional holes may be used to provide egress for the storm runoff. The design may also be used to repair existing box drains which have failed.

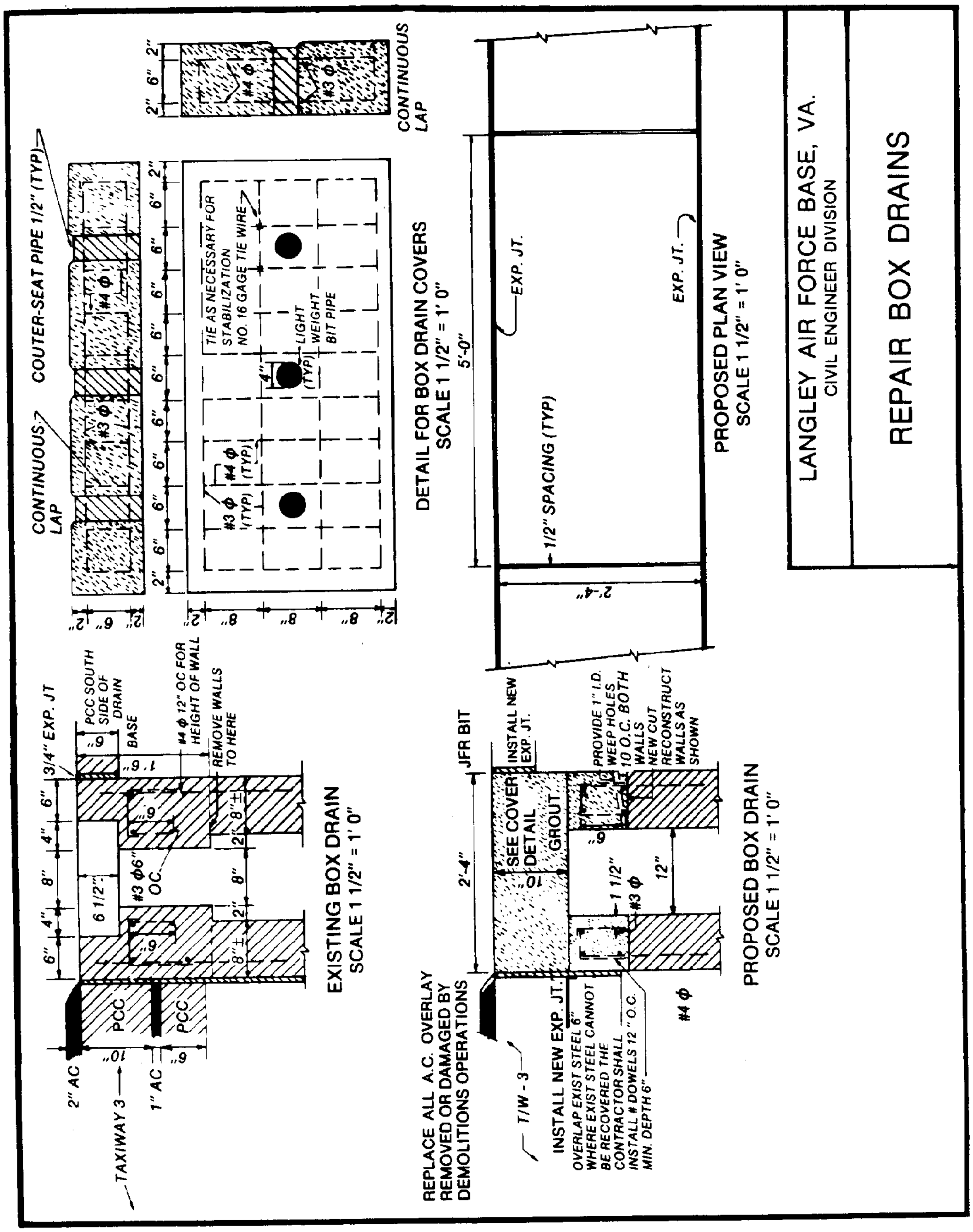

Figure 3-5. Repair box drains.

c. Inlet drainage structures, particularly box drains, have been known to settle at rates different from the adjacent pavement causing depressions which permit pavement failure should the subgrade deteriorate. help Construction specifications requiring careful backfilling around inlets will help prevent the differential settling rates.

3-5. Settlement of inlets and drains.

Failure of joints between sections of concrete pipe in the vicinity of large concrete manholes indicates the manhole has settled at a different rate than that of the connecting pipe. Flexible joints should be required for all joints between sections of rigid pipe in the vicinity of large manholes, say 3 to 5 joints along all pipe entering or leaving the manhole.

3-6. Gutters.

In general, curb and gutters are not permitted to interrupt surface runoff along a taxiway or runway. The runoff must be allowed unimpeded travel transversely off the runway and thence directly by the shortest route across the turf to the field inlets. Inlets spaced throughout the paved apron construction must be placed at proper intervals and in well-drained depressed locations. Gutters are discussed in chapter 4.

3-7. Curb inlets.

The hydraulic efficiency of curb inlets depends upon depression of gutter invert and a relatively high curb; these conditions cannot be tolerated on airfield or heliport pavements and therefore will not be used.

3-8. Clogging.

Partial or total restriction of open and grated inlets caused by clogging with debris, sediments, and vegetation is a fairly common problem.

a. Major factors responsible for clogging of inlets are inadequate periodic inspection, inadequate maintenance, and improper location of the inlet relative to the hydraulic gradient in the drainage system.

b. To prevent clogging of inlets serving drainage basins with characteristics and flows that contribute and transport detritus, debris barriers should be provided upstream of them.

3-9. Ladders.

Adequate ladders should be provided to assure that rapid entrance and egress may be made by personnel during inspection of facilities. Ladder rungs should be checked periodically, since they are often lost in the course of regular inspection and maintenance work.